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Paediatric outcomes and timing of admission

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ABSTRACT

Studies of adult patients have demonstrated that weekend compared to weekday admissions had a significantly higher hospital mortality rate at weekends. We have reviewed the literature to determine if the timing of admission, for example, weekend or weekday, influenced mortality and morbidity in children. Seventeen studies reported the effect of timing of admission on mortality mortality, only four demonstrated an increase in those admitted at the weekend. Meta-analysis of the results of 15 of the studies demonstrated there was no significant weekend effect. There was, however, considerable heterogeneity in the studies. There were two large UK studies, one reported an increased mortality only for planned weekend admissions likely explained by planned admissions for complex conditions and the other showed no significant weekend effect. Two studies, one of which was large (n=2,913) reported more surgical complications in infants undergoing weekend oesophageal atresia and trachea-oesophageal repair. Medication errors have also been reported to be more common at weekends. Five studies reported the effect of length of stay, meta-analysis demonstrated a significantly increased length of stay following a weekend admission, the mean difference was approximately one day. Those data, however, should be interpreted with the caveat that there was no adjustment in all of the studies for differences in disease severity. We conclude, weekend admission overall does not increase mortality, but may be associated with a longer length of stay and, in certain conditions, with greater morbidity.

INTRODUCTION

In 2001, it was reported that weekend admissions when compared to weekday admissions of 3,789,917 adults and children admitted through an emergency department to an acute care hospital in Canada had a significantly higher in-hospital mortality rate if they had a ruptured abdominal aortic aneuyrism, acute epiglottis or pulmonary embolism.[1] The differences persisted for all diagnoses after adjustment for age, sex and co-existing disorders.[1] A subsequent retrospective analysis of deaths of all 14,217,640 admissions to the English National Health Service during the financial year 2009/2010 demonstrated that 30 day mortality was increased in those admitted on weekend days, although the likelihood of death occurring was less on a week end day than on a mid-week day.[2] More recently an analysis of deaths of 503,938 unselected emergency admissions to four UK hospitals was undertaken. Deaths within 30 days within 30 days of admission occurred in 18,313 (4.7%) patients admitted on a weekday and 6,070 (5.1%) patients admitted at the weekend ($p<0.001$). Adjustment for routine haematology and biochemistry tests substantially reduced the excess mortality associated with emergency admissions at weekends and public holidays. No hospital workload measure was independently associated with mortality. Adjustment for patient level factors was not available in the study, but it was postulated that such an adjustment might have further reduced the residual excess mortality, as this was clustered around midday at weekends.[3]

The infant mortality rate in England and Wales is 3.6 per 1,000 live births and the child mortality rate 1 per 1,000 [4], both are much lower than the adult mortality rate. Nevertheless, it is important to assess whether there is a weekend effect on mortality and other adverse outcomes in paediatric populations. We, therefore, have reviewed the literature to identify if there were significant differences according to admission at the weekend or weekdays regarding mortality, procedure complications, length and cost of

hospital stay, medication errors and unplanned readmission rates. These are important questions to address as the results may have implications for redirection of health services resources to reduce adverse outcomes.

Mortality

Seventeen studies have reported the effect of timing of admission on mortality.[5-21] Only four of the studies [5, 9, 12, 17] demonstrated an increased mortality at the weekend. One study [16] showed amongst 234,192 admissions to PICU in the USA, despite off hours admissions having higher acuity, after adjustment such admissions had a significantly lower odds of mortality (odds ratio (OR) 0.91, 95% confidence intervals (CI) 0.86-0.95). Similarly, examination of 4,456 emergency admissions to a PICU in an Australian hospital demonstrated that the risk adjusted mortality was lower in after hours (OR 0.712, 95% CI 0.518-0.980). In hours were 0800-1800 on Monday to Friday and 0800 to 1200 on Saturday and Sunday, after hours were all other times.[18] Meta-analysis was undertaken of the results of fifteen of the studies (see the supplement for information regarding the analysis). This demonstrated a significant increased risk of mortality at the weekend (typical relative risk (RR) 1.37 (95% CI (CI) 1.07, 1.76)) (Figure 1) but the effect was no longer significant once adjusted data were analysed (Figure 2). Importantly, however, different adjustments were used in the various studies and there was considerable heterogeneity between the studies (Table 1). This included the comparator time periods during the week, for example the length of the weekend varied from 1900 on Friday to 0700 on Monday compared to Saturday 1200 to Sunday 2400. Others compared out of hours compared to regular hours which were 0700 to 1900 on weekdays; another definition of out of hours was nights, weekends and public holidays. This may have influenced the results as for example in one study of 20,547 PICU admissions, although there was no weekend effect on mortality, there was an excess of mortality in children admitted during the evening compared to during day time hours.[6] This was not confirmed in another study, but it was much smaller (n=210).[7]

Of those that showed a significant adverse weekend effect, one assessed 19,386 children aged one to eighteen years of age in the USA who were admitted with ischaemic or haemorrhagic stroke.[5] A limitation of the study was that it relied on the correct coding of the diagnoses in the database.[5] Another examined the outcome of 12,893 children older than or equal to 90 days admitted to a rural hospital in Kenya. Although deaths within four hours and four to forty-eight hours of admission were significantly higher at the weekend, deaths beyond 48 hours were not.[9] A further study examined 439,457 patients less than 18 years of age who required surgery on the same day of admission. After adjusting for confounding variables at the weekend, the odds ratio (OR) for the risk of death was 1.63 (95% CI 1.21-2.2).[12] Two large studies reported UK findings. In one [17], a nationwide paediatric intensive care audit was undertaken of 86,000 admissions. Nearly half (47.1%) of the admissions were out of hours and 79.2% of those were emergency admissions. The risk adjusted mortality for planned admissions was OR 1.99 (1.67-2.37), but there was no significant risk for emergency admissions (OR 0.93, 95% CI 0.86-1.01). The overall raised mortality for out of hours admissions was suggested by the authors to be accounted for by planned admissions following complex operations.[17] In the other large UK based study, 19,729 patients were included with 12,697 being under 15 years of age. The case related fatality rates following admission for meningococcal disease were reported.[11] No significant differences were reported between weekend and weekday admissions and, after undertaking sensitivity analyses and analysing multivariate models, the lack of a weekend effect remained.

Complication rates

A number of studies have assessed whether complications were increased at the weekend. The complications included increased unplanned readmission rates [22], increased complication rates [10, 12, 13, 21, 23], treatment delay [14] and increased medication errors.[24] In a study of 55,383 children in the USA (new-borns and children who died were

excluded), weekend admission was associated with a significantly higher odds of an unplanned readmission in 30 days, but weekend discharge was not associated with a significantly higher unplanned readmission rate.[22]. There appears to be a weekend effect regarding certain procedural complications. In a retrospective cohort of 580 patients less than 18 years of age undergoing 710 urgent or emergency neurosurgical procedures in a Texas Children's Hospital there was a significant excess of surgical complications at weekends and weekdays after hours.[10]. In a small study of 28 patients undergoing oesophageal atresia and trachea-oesophageal repair, there were significantly more oesophageal leaks in those admitted after hours [23] and this was associated with a longer post-operative length of ventilation (16.1 versus 9.3 days).[23] Those findings [23] were confirmed in a larger cohort (n=861) of infants less than eight days of age undergoing oesophageal atresia and trachea-oesophageal repair identified from the USA Kid's Inpatient Database. A greater rate of surgical complications were reported in those undergoing a weekend procedure (OR 2.2, 95% CI 1.01-4.8) [21]. In a study of 439,457 children less than 18 years of age in the USA who required surgery on the day of admission, there was an increase in procedural complications and receipt of blood transfusions despite similar intraoperative haemorrhage at the weekend.[12]. In contrast, the overall complication rate was lower out of hours in 176 children requiring extracorporeal membrane oxygenation (ECMO) in a tertiary centre.[13]. Weekend admission was not associated with a significant excess of mortality amongst 12,043 children with newly diagnosed acute lymphocytic leukaemia or acute myeloid leukaemia, but the length of admission was on average 1.4 days longer and the time to start chemotherapy was 0.3 days later (both differences were statistically significantly).[14] In addition, children had an increased risk of respiratory failure if admitted at the weekend (OR 1.5, 95% CI 1.2-1.7).[14] In a report of 140 medication errors occurring in a tertiary paediatric hospital, the rate of errors per 1000 doses were significantly higher on weekend days compared to week days (2.25 versus 1.17, p=0.004).[24]

Length of stay

Five studies have reported the effect of timing of admission on length of stay [14, 18, 25-27] A number of studies reported an increased length of stay in those admitted at the weekend, but it is important to appreciate that this was not the case in all studies [18, 27] and the populations assessed in the various studies were very heterogenous. In 23,332 children aged less than two years of age admitted with a diagnosis of failure to thrive to USA hospitals, weekend admission was significantly correlated with increased length of stay. The average increase in the length of stay of 1.93 days and was associated with an increase in the cost of care.[25]. Amongst 10,042 patients admitted to a ward in a Children's Hospital in Poland which treated heamato-oncology, diabetic and nephrology patients, after controlling for clinical factors, weekend admission was associated with a longer duration of hospital stay by on average 1.86 days.[26] In contrast in 549 patients undergoing a planned Norwood procedure with a diagnosis of hypoplastic left heart syndrome or other single right ventricle anomalies in the Children's Hospital in Chicago, after adjusting for known risk factors for poor outcomes, there was no significant effect on length of stay, length of PICU stay, duration of ventilation or mortality.[27] Furthermore, another study of PICU patients demonstrated than amongst 4,456 emergency PICU admissions of children less than 14years of age, after using PIM scoring to adjust for illness severity, the median length of stay was shorter after out of hours admission.[18] Meta-analysis demonstrated an increased length of stay following weekend admission (RR 1.31, 95% CI 0.85, 1.76), the mean difference was approximately one day (Figure 3). The results, however, should be interpreted with caution as adjustment could not be made in all studies for differing illness severity in patients admitted out of hours or at weekends

DISCUSSION

We have not found a significant “weekend” effect on paediatric mortality, but an adverse effect on length of stay and greater complications in certain conditions. Our literature review emphasises the heterogeneity of the studies examining this topic. It was, however, possible to undertake a meta-analysis of the majority of studies on the impact on mortality of weekend admission which demonstrated no significant effect on mortality when adjusted results were used. It is important, however, to re-emphasise that different adjustments were used in the various studies.

The majority of studies have assessed the outcomes of children out with the UK and, therefore, the results must be interpreted with the caveat that they may have been in the context of different healthcare provision. In two large UK studies, in one [11] no significant differences were reported between weekend and weekday admissions and in the other [17] an increase in mortality was seen only in planned weekend admissions and not emergency weekend admissions. Those results [17] highlight it may be case mix that influences results with patients following complex surgery being more likely to be admitted to PICU at the weekend.

We have not reported whether deaths were more likely to occur at the weekend or on a weekday, as this was not available for the majority of studies. Importantly, in the retrospective analysis of deaths of all 14,217,640 admissions to the English National Health, demonstrated that the 30 day mortality was increased in those admitted on weekend days, but the likelihood of death occurring was less on a week end day rather than on a mid-week day.[2] It would be important to determine in UK paediatric populations the timing of deaths to identify if there are any excess deaths at the weekend as that might reflect inadequate “resource” at that time.

None of the studies specifically looked at staffing levels, which could contribute to a "weekend effect". Paediatric staffing is an area of concern, 89% of consultants responding to a Royal College of Paediatrics and Child Health (RCPCH) survey stated that they were very or moderately concerned about how the service would cope in the next six months.[28] The Royal College of Nursing (RCN) [29] and the RCPCH [30] have issued documents detailing standards of staffing and expectations of care for children admitted to hospital. An audit of the medical standards by RCPCH [31] two years after their introduction found that, although they were being met in the majority of cases, there were still improvements to be made to better achieve the standards out-of-hours. The weekend effect may be mitigated by paediatrics being a relatively senior led specialty; 96.4% of units surveyed in 'Consultant Delivered Care' operated some form of consultant delivered care, including 90.3% of consultant led hand-overs.[32]

In conclusion, studies of adult patients had demonstrated a significantly higher in hospital mortality in those admitted at weekends. A recent study, however, suggested that adjustment for acuity reduced that risk. Our review of paediatric studies demonstrated no overall significant adjusted risk for mortality following weekend admissions. There was, however, an increase in complications following weekend procedures in certain conditions. In five studies, there was an increased length of stay following a weekend admission, but it was not possible to adjust in all for patient acuity. The increase in hospital stay and apparent excess in complications in certain conditions in infants and children admitted at the weekend needs further investigation. Those results would identify whether there is a need for redirection of health services resources to reduce adverse outcomes in infants and children.

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FIGURE LEGENDS:

Figure 1: Weekend effect on mortality during admission (unadjusted)

Figure 2: Weekend effect on adjusted mortality during admission

Figure 3: Weekend effect on length of hospital stay

Table 1

	Study group	Study type	Outcome	Exposure	Key result	Comment
Adil et al. [5]	Patients aged one to 18 yrs admitted to USA hospitals between 2002 and 2011 due to ischaemic or haemorrhagic stroke. 19386 patients. Cases found from National Inpatient Sample (NIS).	Retrospective cohort	Mortality Length of stay (LOS) Hospital charges Discharge status	Weekend or weekday admission	Ischaemic stroke; Children admitted at weekends had a higher rate of discharge to nursing facilities (versus home) OR 1.5 (95% CI 1.1-1.9) p=0.006 Haemorrhagic stroke; In hospital mortality was higher in children admitted at weekends OR 1.4 (95% CI 1.1-1.9) p=0.04 LOS and charges were also higher in both groups in children admitted at the weekend	Limited by reliance on correct coding of diagnoses within NIS database and under reporting of co-morbidities. Adjustment was made for age, sex and confounding factors significant (p<0.05) in univariate analysis
Arias et al. [6]	20547 emergency admissions to 15 PICUs in the PICUE database in the USA between 1995-2001.	Retrospective cohort	Mortality within 48 hours of admission to PICU.	Weekend (1900Fri-0700 Monday) or weekday admission Day (0700-1700) or evening (1700-0700)	No significant difference between weekend and weekday admission regarding severity of illness. Death at the weekend OR 1.0 (95% CI 0.78-1.28) Death in the evening OR 1.28 (95% CI 1-1.62)	Used PRISM scoring as method for adjusting for illness severity.
Arslankoylu et al [7]	210 consecutive admissions of children aged one month to 18 years to PICU in a Turkish hospital between 2005-2006.	Retrospective cohort	Mortality within 24 hours, 48 hours, 72 hours and overall. Length of stay. Duration of ventilation.	Weekday or Weekend Daytime (0800-1700) or evening (1700-0800)	No statistically significant difference in mortality rates between weekend and weekday or daytime and evening. Patients admitted during the daytime had greater PIM2 mortality scores (p=0.01) and greater need for mechanical ventilation (p=0.03)	Used PIM2 scoring as a way of adjusting for illness severity.
Attenello et al. [8]	99472 patients aged less than 20	Retrospective cohort	Mortality Routine discharge	Weekday or	Weekend admission was not associated with increased	Multivariate analysis to account for confounding factors which

	yrs between 2000 and 2010 with hydrocephalus identified from NIS and KID databases in the USA.		rate	weekend admission Time to shunt insertion	mortality p=0.46 Weekend admission was not associated with a significant difference in the routine discharge rate RR 1.00 (95% CI 0.97-1.03) p=0.98	included time to shunt insertion. Adjustment for disease severity, time to procedure and admission acuity
Berkley et al. [9]	12893 children aged ≥90 days admitted to a rural Kenyan hospital between 1998-2001.	Prospective cohort	Mortality within 4 hours, 4-48 hours and after 48 hours	Weekend or weekday admission	Adjusted for illness severity, weekend admission; death within four hours was increased (OR 2.05 (95% CI 1.26-3.31)) as was death within 4-48 hours (OR 1.54 (95% CI 1.17-2.03)) Death beyond 48 hours was not (OR 1.09 (95% CI 0.8-1.47))	Created their own prognostic indicator score and used this to adjust for illness severity.
Desai et al. [10]	580 patients less than 18yrs undergoing 710 emergency neurosurgical procedures between 2011 and 2014 in a Texas Children's Hospital.	Retrospective cohort	Mortality Surgical complications (including infection, CSF leakage, post operative haemorrhage, and new neurological deficit)	Weekday hours (0720-1900) or weekday out-of-hours or weekend (Saturday 1200-Sunday 2400) procedure	Combined morbidity and mortality at nights and weekends OR 1.79 (95% CI 1.083-2.961) p=0.0227 No significant difference in mortality (p=0.058), but only three deaths in total. No significant differences in complications between groups.	Accounted for baseline health status using anaesthetic scoring system (ASA).
Goldacre et al. [11]	All patients with a discharge diagnosis of meningococcal disease as per HES and mortality records from 1999-2010.	Retrospective cohort	Mortality	Weekend or weekday admission	30 day case fatality rates showed no evidence of increased mortality for patients admitted at weekend; p=0.92 No significant change when adjusted for confounding	Adjusted for sex, age, year of admission, IMD score and day of the week of admission

	12697 patients aged less than 15 years				factors	
Goldstein et al. [12]	439457 patients less than 18 yrs old requiring surgery abscess drainage, appendicectomy, hernia repai/VP shunt) on same day as admission using the NIS and KID databases between 1988-2010.	Retrospective cohort	Mortality Haemorrhage Accidental puncture or laceration Wound dehiscence Wound infection Blood transfusion	Weekend or weekday admission	: Risk of death OR 1.63 (95% CI 1.21-2.2) Accidental puncture or laceration OR 1.4 (95% CI 1.12-1.74) Blood transfusion OR 1.14 (95% CI 1.01-1.26)	Looked at number of ICD9 codes associated with each patient as a way of assessing co-morbidities. Adjusted for age, gender, race, insurance status, comorbid diagnoses, geographical region, type of hospital, admission type and surgical procedure
Gonzalez et al. [13]	176 patients aged less than 18 yrs undergoing extracorporeal Life support (ECMO) between 2004 and 2015 in a tertiary centre in the USA	Retrospective cohort	Mortality Survival to discharge. Complications including haemorrhage cannula repositioning and conversion from venovenous to venoarterial ECMO	Regular-hours (0700-1900) or out-of-hours (including weekends) (off hours)	The overall complication rate was lower in off-hours group 45.7% versus 61.9% p=0.034	Commonest indication fo r ECMO were congenital diaphragmatic hernia (CDH) and persistent pulmonary haemorrhage (23%)
Goodman et al. [14]	Children with newly diagnosed acute lymphocytic leukaemia or acute myeloid leukaemia admitted to hospital between 1999-2011 and identified by the Pediatric Health Information System database. 12043 admissions in 43 USA hospitals	Retrospective cohort	Mortality during primary admission Length of inpatient stay Time to chemotherapy Organ system failure	Weekend or weekday admission	Weekend mortality rate OR 1.0 (95% CI 0.8-1.6) If admitted at weekend; admission duration 1.4 days longer (95% CI 0.7-2.1), time to chemotherapy initiation 0.36 day longer (95% CI 0.3-0.5) and risk of respiratory failure OR 1.5 (95% CI 1.2-1.7)	Adjusted for severity of illness at presentation defined as requiring PICU within 48 hours of hospital admission, demographics and hospital level.

Hixson et al. [15]	5968 patients aged 0-21 years admitted to a PICU in a single hospital in the USA between 1996-2003.	Prospective cohort	Mortality prior to discharge from hospital	Weekday or Weekend Daytime (0700-1900) or evening (1900-0700)	Following adjustment for confounding variables there was no significant difference in death rate at weekends or in the evenings; Weekend p=0.146 Evening p=0.711	Used PRISM3 to assess for illness severity.
McCrory et al. [16]	All patients less than 18 yrs admitted to a PICU between 2009-2012. 23,4192 admissions to 99 USA PICUs	Retrospective cohort	Mortality during PICU admission	In-hours (0700-1859 Monday-Friday) or off-hours (1900-0659 or Saturday/Sunday anytime)	Weekend death OR 1.01 (95% CI 0.94-1.09) p=0.79 Night death OR 0.86 (95% CI 0.81-0.92) p<0.0001 Risk of death between hours 0600-1100 OR 1.27 (95% CI 1.26-1.39) p=<0.0001	Used PRISM scoring as a way of assessing severity of illness. Data adjusted for confounders including illness severity. No evidence of increased out of hours mortality
McShane et al. [17]	All patients admitted to 29 PICUs in England and Wales between 2006-2011. 86980 patients and 4087 deaths.	Retrospective cohort	Mortality before discharge from PICU	Out-of-hours (nights, weekends and public holidays) or In-hours admission	47.1% of admissions were out of hours, with 79.2% being emergency admissions. Risk-adjusted mortality for planned admissions was higher out-of-hours OR 1.99 (95% CI 1.67-2.37) p<0.001 but not for emergency admissions OR 0.93 (95% CI 0.86-1.01) p=0.07	Adjustment PIM2, year of admission, sex ethnicity, age group and diagnostic group
Numa et al. [18]	4456 emergency PICU admissions of children aged 0-14 years in an Australian hospital between 1997-2006.	Prospective cohort	PICU mortality Length of stay	In-hours (0800-1800 Monday-Friday and 0800-1200 Saturday-Sunday) or After-hours (all other times)	Following adjustment for illness severity. After-hours risk of death OR 0.712 (95% CI 0.518-0.980) p=0.037 Shorter median length of stay for after-hours versus in-	Used paediatric index of mortality (PIM) scoring to adjust for illness severity.

					hours admissions	
Nwosu et al. [19]	All inpatient deaths (3934) at a tertiary referral hospital in Nigeria occurring between 1998 and 2007.	Retrospective cohort	Mortality	Weekend or weekday	Weekend deaths less in SCBU (Ratio 0.88), Paediatric ward (Ratio 0.88) and Children's ED (Ratio 0.87) The labour ward had significantly higher weekend to week day death rates of 1.72:1	Ages ranged from a few hours to 94 years
Peeters et al. [20]	All emergency PICU admissions for children aged less than 18years in two hospitals in the Netherlands between 2003-2007. 3212 admissions	Prospective cohort	PICU mortality Duration of ventilation Length of PICU admission	Office hours (0800-1800 Mon-Fri) or off-hours (1800-0800 Monday-Friday and all weekends and bank holidays)	66% patients admitted during off-hours. Adjusting for severity of illness there was no significant effect of off-hours admission on mortality. PIM1 score OR 0.95 (95% CI 0.71-1.27) p=0.73 PRISM2 score OR 1.03 (95% CI 0.76-1.39) p=0.82	Used PIM1 and PRISM2 scoring systems to adjust for severity of illness.
Sayari et al. [21]	Patients admitted between 1997-2009 aged less than 8 days and undergoing repair of tracheo-oesophageal fistula and oesophageal atresia underwent repair. Cases found from KID (Kids' Inpatient Database) US 2913 cases.	Retrospective cohort	Hospital mortality Complications Resource use Total charges	Weekend or weekday procedure	Weekend vs weekday surgical procedure had no significant effect on mortality or resource utilisation p≥0.05 Surgical complication rates were higher in those undergoing a weekend procedure OR 2.2 (95% CI 1.01-4.8) p=0.048	Additional adjustment made for comorbid risk factors.
Auger et al. [22]	55383 paediatric patients from a US hospital between 2006 and 2012.	Retrospective cohort	Unplanned readmission within 30 days of discharge	Weekend admission or weekend discharge	Weekend admission had significantly higher odds of unplanned readmission adjusted OR=1.09 (95% CI	ICD9 codes used to identify children with chronic complex conditions.

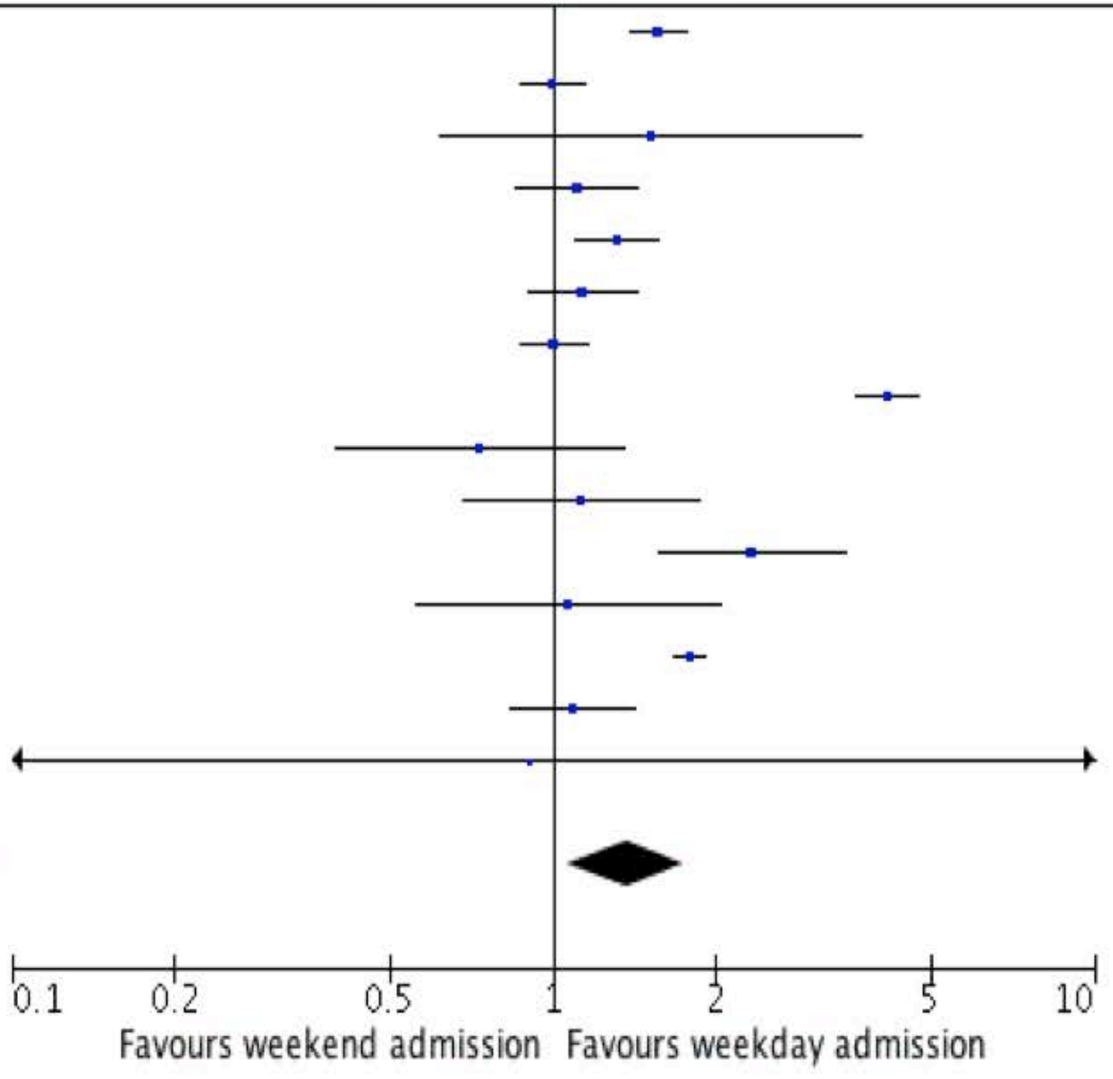
	Newborns and children who died were excluded.				1.004-1.18) p<0.05 Being discharged on the weekend was not associated with unplanned readmission adjusted OR = 0.97 (95% CI 0.91-1.03)	
Yeung et al. [23]	28 patients between 2005-2010 undergoing oesophageal atresia with tracheoesophageal fistula repair at a tertiary children's hospital Canada.	Retrospective cohort	Mortality Intraoperative complications Oesophageal complications Pneumothorax	In-hours (0800-1530 Monday-Friday) or after-hours (remaining time period including weekends and bank holidays)	Significant increase in oesophageal leaks in after-hours group p=0.014 Post-operative ventilation time significantly longer in after-hours group (16.1 days versus 9.3 days) p<0.001. No significant difference in mortality	Small sample size.
Miller et al. [24]	Review of 140 reported Paediatric medication errors occurring in a tertiary USA paediatric hospital in 2008	Retrospective cohort	Medication dispensing errors (pharmacy and nursing)	Day or Night or Weekday (Monday 0700-Friday 1859) or Weekend	Weekday day nursing shift 1.17 errors/1000 doses versus Weekend 2.55 errors/1000 doses (p = 0.0004) or versus Night 2.12 errors/1000 doses dispensed (p = 0.005) No significant association between time and severity of the error	Administration errors were most common
Thompson et al. [25]	Children less than two years of age with a primary admission diagnosis of failure to thrive between	Retrospective cohort	Length of hospital stay Cost of admission	Weekend or weekday admission	Patients admitted at the weekend had longer LOS incident rate ratio (IRR) 1.2 (95% CI 1.18-1.22) p<0.002 Weekend admissions cost	Results adjusted for the number of discharge diagnoses.

	2003-2011 in 42 US hospitals. 23332 cases from the PHIS database.				more and had an increased LOS of 1.93 days	
Fendler et al. [26]	10042 patients admitted to a ward treating haemato-oncology, diabetic and nephrology patients in a Children's Hospital in Poland between 2000-2010.	Retrospective cohort	Length of hospital stay	Weekend or weekday admission	Weekend admission was associated with a longer duration of hospital stay by 1.86 days (95% CI 1.6-2.13).	Controlled for other clinical factors
Johnson et al. [27]	Patients with a diagnosis of hypoplastic left heart syndrome or other single right ventricle anomalies and a planned Norwood procedure	Retrospective cohort	Mortality Hospital length of stay Transplant-free survival Intensive care unit length of stay Days of mechanical ventilation	Weekend or weekday admission and day of procedure	No difference in death (p=0.9), hospital (p=0.7) or ICU (p=0.5) length of stay, days ventilated (p=0.3) between weekend and weekday groups.	Known risk factors for poor post-Norwood procedure outcomes were controlled for.

Study or Subgroup	Weekend Events	Weekend Total	Weekday Events	Weekday Total	Weight	Odds Ratio M-H, Random, 95% CI
Adil 2016	415	4618	879	14768	8.1%	1.56 [1.38, 1.76]
Arias 2004	332	7052	636	13495	8.1%	1.00 [0.87, 1.14]
Arslankoylu 2008	8	46	20	164	4.0%	1.52 [0.62, 3.71]
Attenello 2015	70	15916	332	83556	7.6%	1.11 [0.86, 1.43]
Berkley 2004	171	2754	487	10139	8.0%	1.31 [1.10, 1.57]
Gathara 2013	126	996	216	1905	7.7%	1.13 [0.90, 1.43]
Goldacre 2013	262	5315	678	13798	8.1%	1.00 [0.87, 1.16]
Goldstein 2014	529	112064	373	327393	8.1%	4.16 [3.64, 4.75]
Gonzalez 2016	38	105	31	71	5.5%	0.73 [0.40, 1.35]
Goodman 2014	19	2009	84	10034	6.2%	1.13 [0.69, 1.87]
Hixson 2005	32	641	118	5343	6.8%	2.33 [1.56, 3.47]
Johnson 2015	13	71	80	462	5.3%	1.07 [0.56, 2.05]
McShane 2013	2484	40948	1603	46032	8.3%	1.79 [1.68, 1.91]
Peeters 2010	181	2122	86	1090	7.6%	1.09 [0.83, 1.42]
Yeung 2015	0	7	1	21	0.5%	0.91 [0.03, 24.90]
Total (95% CI)		**194664**		**528271**	**100.0%**	**1.37 [1.07, 1.76]**
Total events	4680		5624			

Heterogeneity: $Tau^2 = 0.20$; $Chi^2 = 337.76$, df = 14 ($P < 0.00001$); $I^2 = 96\%$

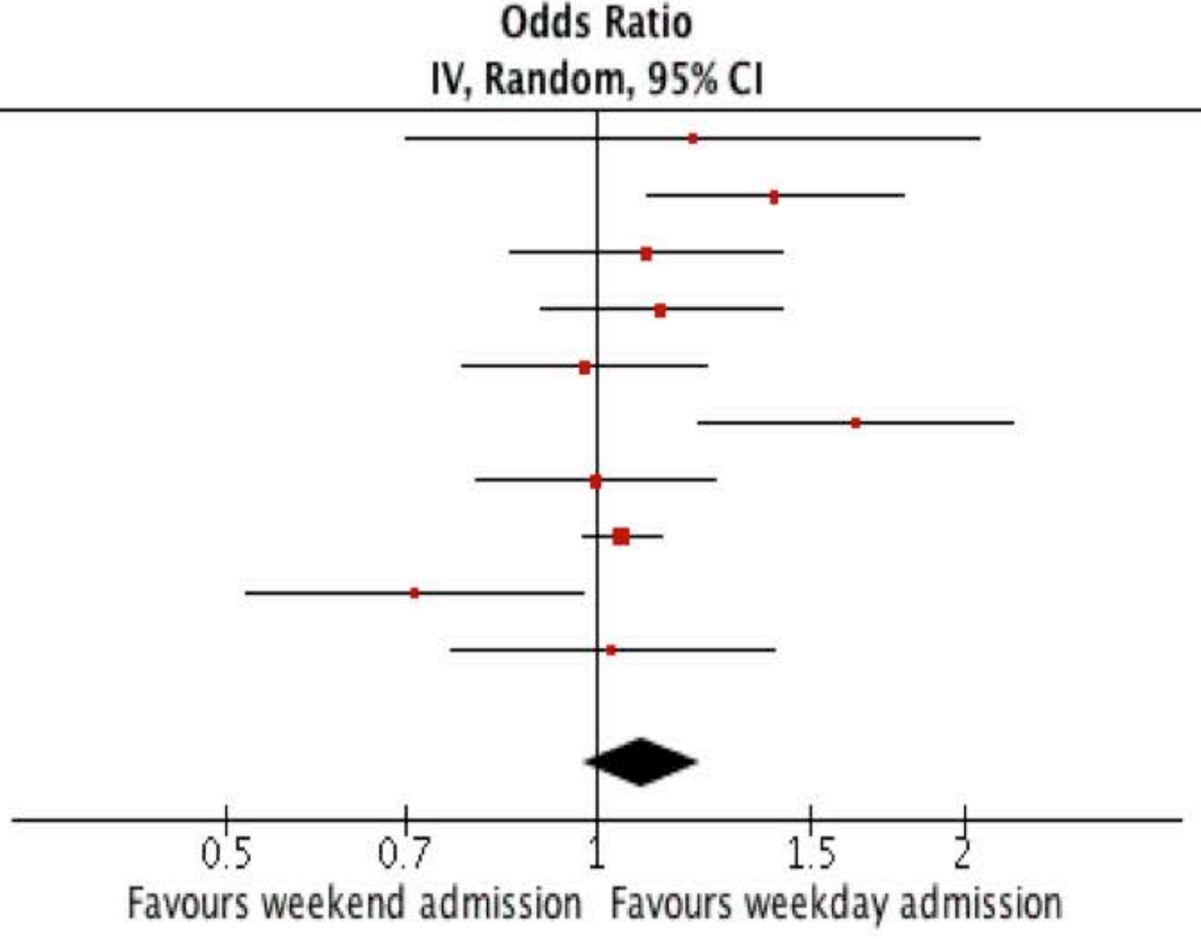
Test for overall effect: $Z = 2.46$ ($P = 0.01$)



Study or Subgroup	log[Odds Ratio]	SE	Weight	Odds Ratio IV, Random, 95% CI
Adil 2016	0.1823	0.275	3.5%	1.20 [0.70, 2.06]
Adil 2016	0.3365	0.123	10.4%	1.40 [1.10, 1.78]
Attenello 2015	0.0953	0.1315	9.8%	1.10 [0.85, 1.42]
Gathara 2013	0.1222	0.1161	11.0%	1.13 [0.90, 1.42]
Goldacre 2013	-0.0202	0.1165	11.0%	0.98 [0.78, 1.23]
Goldstein 2014	0.4886	0.152	8.3%	1.63 [1.21, 2.20]
Goodman 2014	0	0.1139	11.2%	1.00 [0.80, 1.25]
McShane 2013	0.0488	0.0378	19.0%	1.05 [0.98, 1.13]
Numa 2008	-0.3397	0.1623	7.6%	0.71 [0.52, 0.98]
Peeters 2010	0.0296	0.1551	8.1%	1.03 [0.76, 1.40]
Total (95% CI)			**100.0%**	**1.09 [0.98, 1.22]**

Heterogeneity: $Tau^2 = 0.02$; $Chi^2 = 20.41$, df = 9 (P = 0.02); $I^2 = 56\%$

Test for overall effect: Z = 1.57 (P = 0.12)



Study or Subgroup	Weekend Mean	Weekend SD	Weekend Total	Weekday Mean	Weekday SD	Weekday Total	Weight	Mean Difference IV, Random, 95% CI
Adil 2016	9.1997	11.9298	4618	8.1036	13.1785	14768	43.8%	1.10 [0.69, 1.50]
Arslankoylu 2008	10	13	2770	9	14	8149	32.6%	1.00 [0.43, 1.57]
Goodman 2014	17.8	18.2	1990	15.8	16.2	9950	19.8%	2.00 [1.14, 2.86]
Hixson 2005	15.6	27.0756	641	12.9	37.286	5343	3.7%	2.70 [0.38, 5.02]
Yeung 2015	37.31	22.37	7	30.74	23.66	21	0.1%	6.57 [-12.85, 25.99]
Total (95% CI)			**10026**			**38231**	**100.0%**	**1.31 [0.85, 1.76]**

Heterogeneity: $Tau^2 = 0.08$; $Chi^2 = 5.93$, df = 4 (P = 0.20); $I^2 = 33\%$

Test for overall effect: Z = 5.60 (P < 0.00001)